Title: METHOD AND APPARATUS FOR REFRIGERATION SYSTEM CONTROL HAVING ELECTRONIC EVAPORATOR PRESSURE REGULATORS
Inventor: Abtar Singh et al.
Atty. Ref. No.: 4731-000001/COD

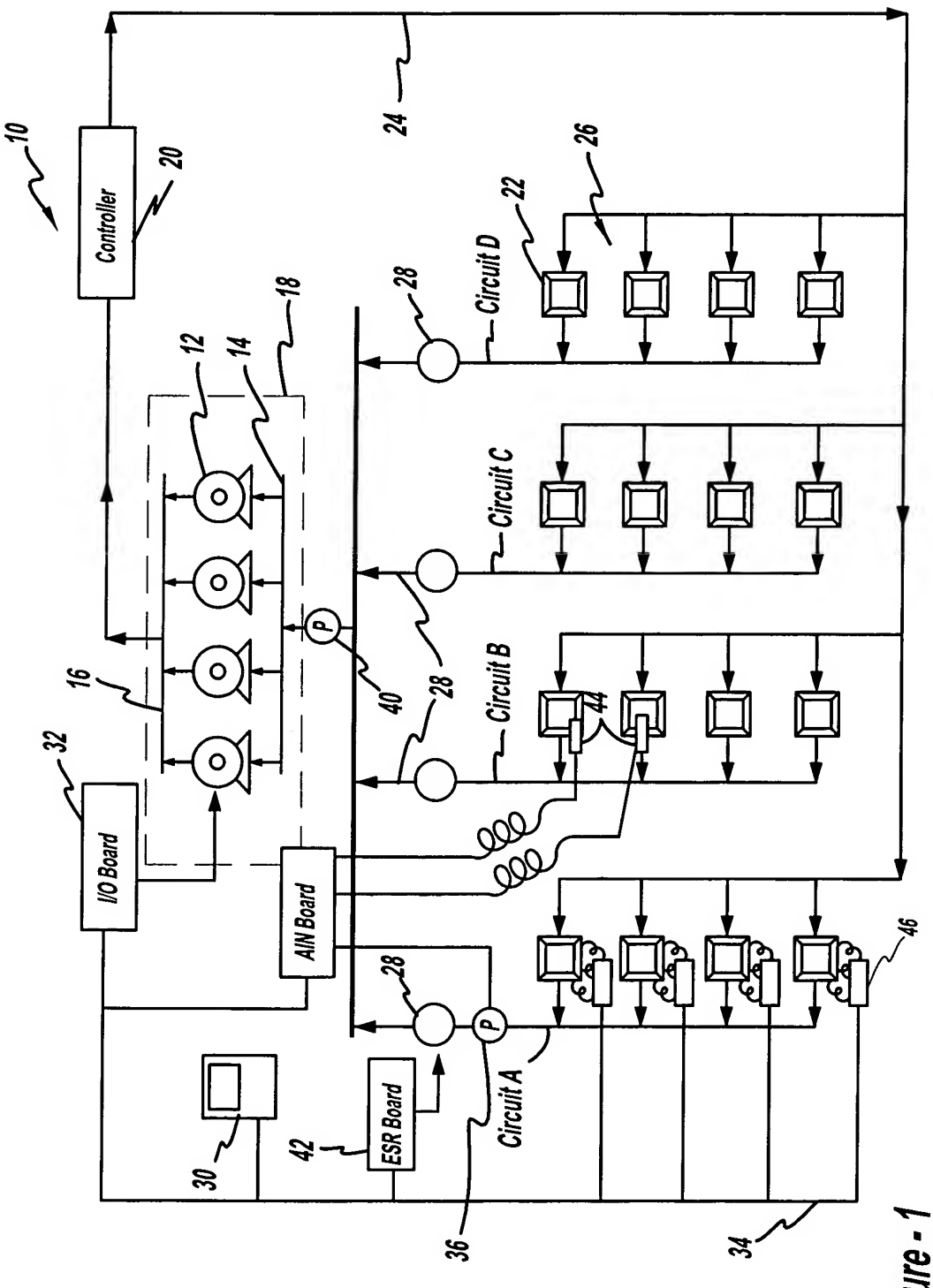

Figure - 1

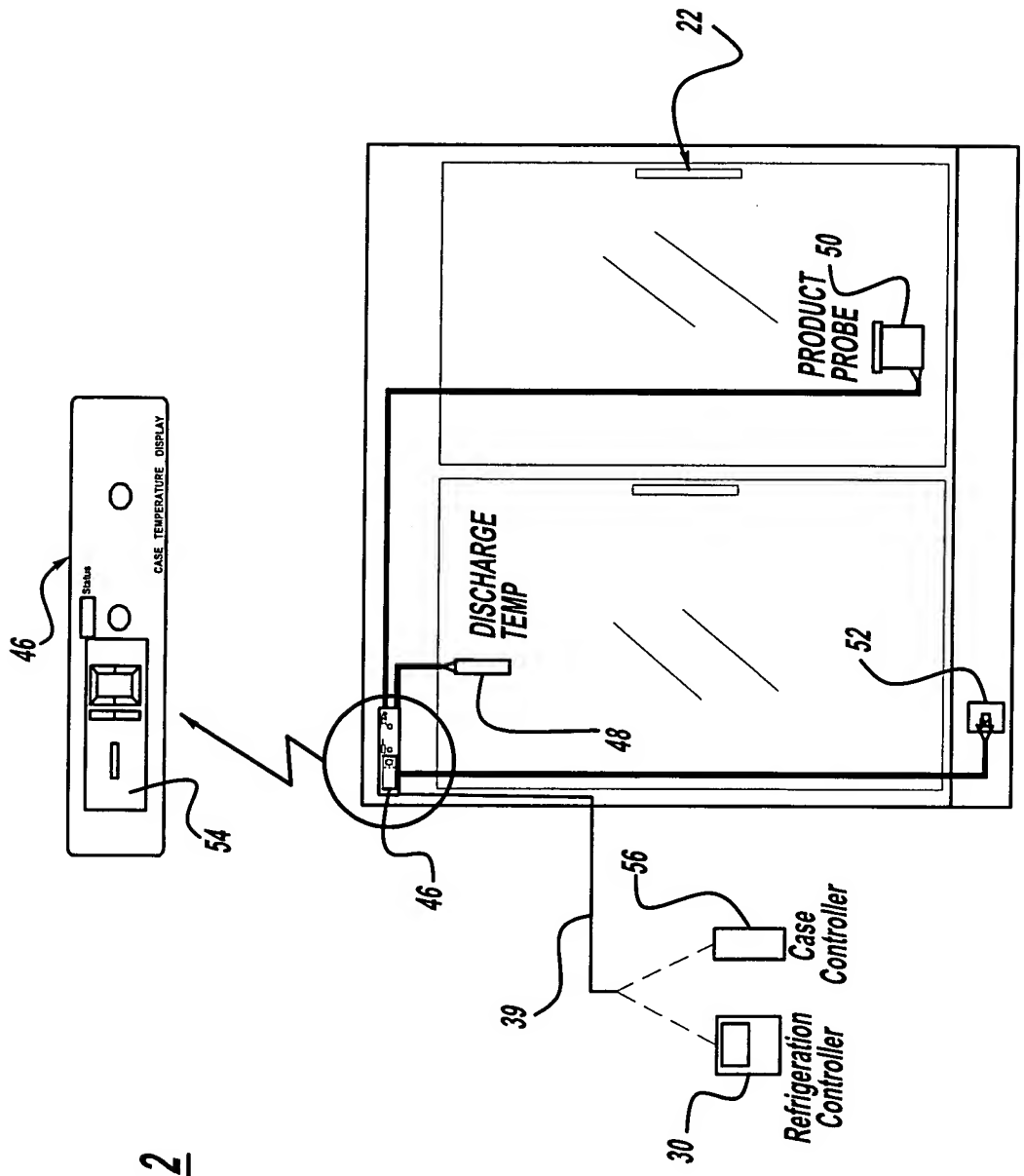
22
PRODUCT PROBE
50
DISCHARGE TEMP
48
52
CASE TEMPERATURE DISPLAY
Status
46
54
46
56
Case Controller
39
Refrigeration Controller
30

Figure - 2

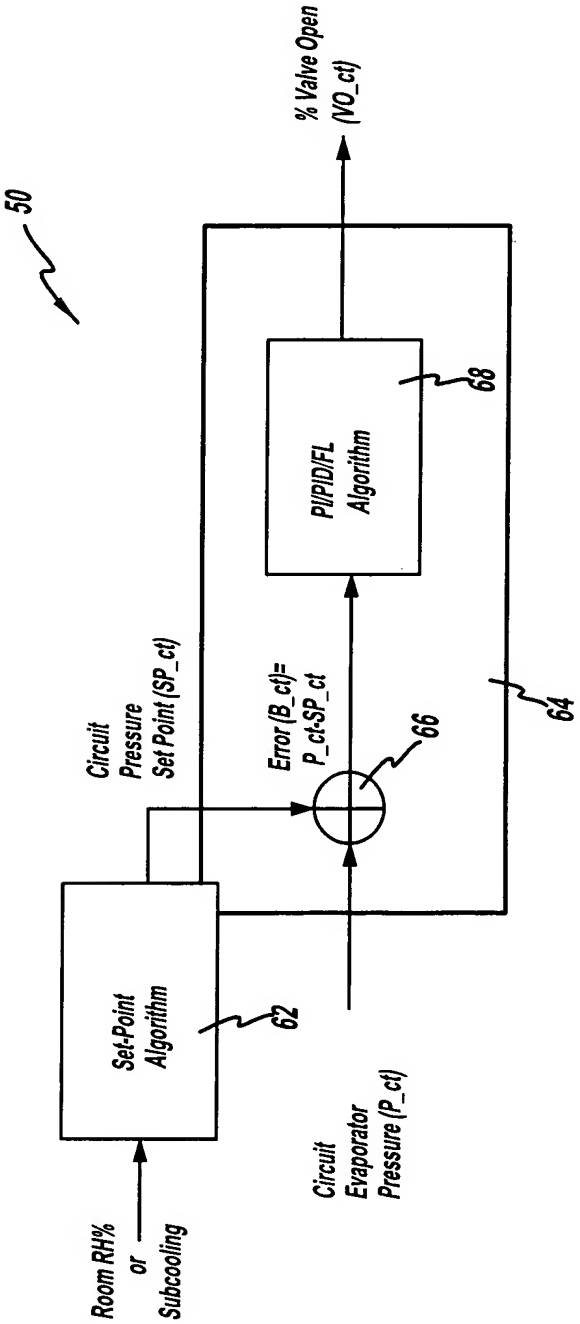
50
% Valve Open (VO_ct)
PI/PID/FL Algorithm
68
Error (B_ct)= P_ct-SP_ct
66
64
Circuit Pressure Set Point (SP_ct)
Set-Point Algorithm
62
Circuit Evaporator Pressure (P_ct)
Room RH% or Subcooling

Figure - 3

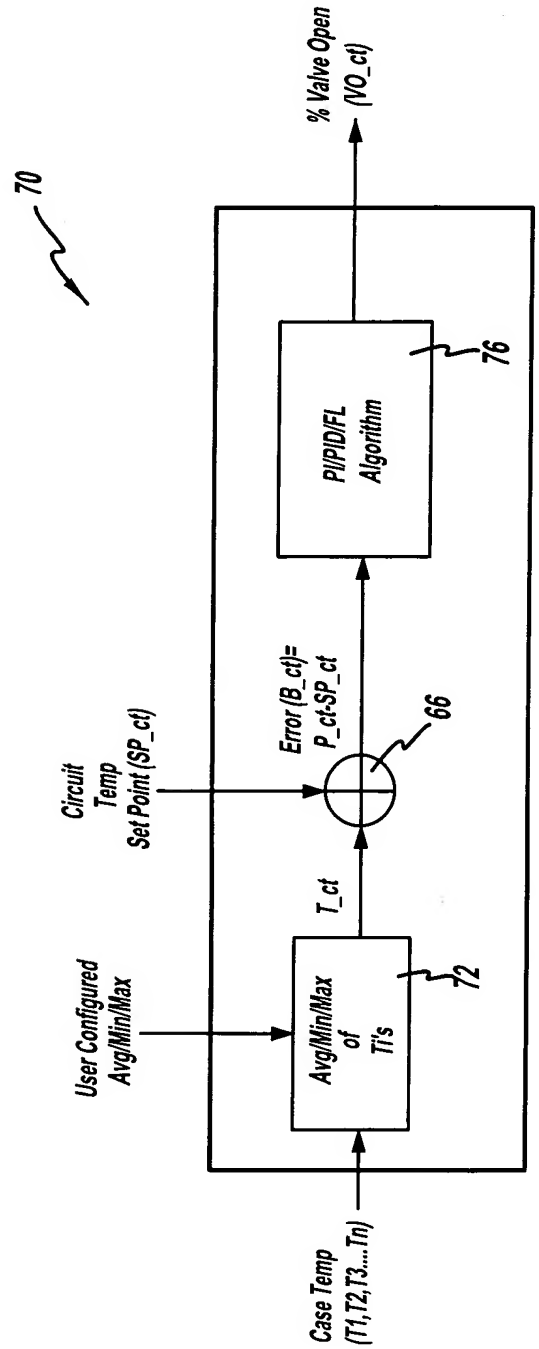
70
% Valve Open
(VO_ct)
PI/PID/FL
Algorithm
76
Error (B_ct)=
P_ct-SP_ct
66
Circuit
Temp
Set Point (SP_ct)
T_ct
User Configured
Avg/Min/Max
Avg/Min/Max
of
Ti's
72
Case Temp
(T1,T2,T3....Tn)

Figure - 4

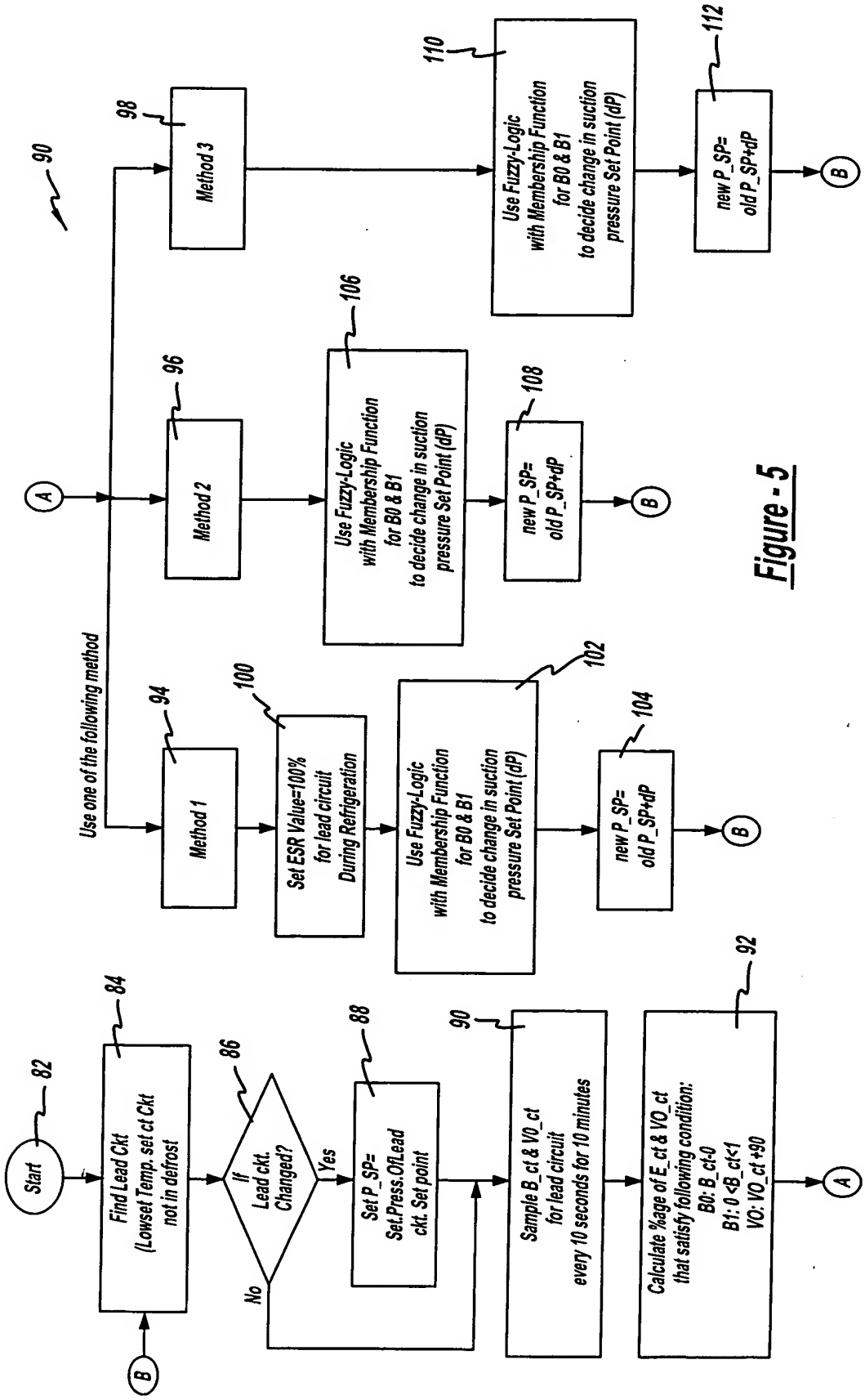
Start
82
Find Lead Ckt
(Lowset Temp. set ct Ckt
not in defrost
84
If
Lead ckt.
Changed?
86
Yes
No
Set P_SP=
Set.Press.OfLead
ckt. Set point
88
Sample B_ct & VO_ct
for lead circuit
every 10 seconds for 10 minutes
90
Calculate %age of E_ct & VO_ct
that satisfy following condition:
B0: B_ct-0
B1: 0 <B_ct<1
VO: VO_ct +90
92
A
B
Use one of the following method
90
Method 1
94
Set ESR Value=100%
for lead circuit
During Refrigeration
100
Use Fuzzy-Logic
with Membership Function
for B0 & B1
to decide change in suction
pressure Set Point (dP)
102
new P_SP=
old P_SP+dP
104
Method 2
96
Use Fuzzy-Logic
with Membership Function
for B0 & B1
to decide change in suction
pressure Set Point (dP)
106
new P_SP=
old P_SP+dP
108
Method 3
98
Use Fuzzy-Logic
with Membership Function
for B0 & B1
to decide change in suction
pressure Set Point (dP)
110
new P_SP=
old P_SP+dP
112

Figure - 5

Figure - 6

Graph 6A

Graph 6B

Note:EO is the percentage of E_ct that is less than zero in 10 minute duration
E1 is the percentage of E_ct that is between zero anf 1 F in 10 minute duration

TRUTH TABLE 6C

E0(I) \ E1(J)	1	2	3
	Lo	Avg	Hi
1 Lo	NBC	NSC	NC
2 Avg.	PSC	PSC	PSC
3 Hi	PBC	PBC	PBC

Quantity Changed:

NBC: Negative Big Change=-2 Psi
NSC: Negative Small Change=-1 Psi
NC: No Change=0 Psi
PSC: Positive Small Change=+1 Psi
PBC: Positive Big Change=+2 Psi

Sample Calculation: For E0=40%: E1=30%

Step1: Fuzzification:

For E0=40% from Mem. Function Chart for E0 we get E0_Lo=0.25; E0_Avg=0.75
For E1=30% from Mem. Function Chart for E1 we get E1_lo=0.5; E1_Avg=0.5

Step2: MinMax: Refer to Truth Table

E0_Lo=0.25 and E1_Lo=0.5 => NBC=Min(0.25,0.50)=0.25
E0_Lo=0.25 and E1_Avg=0.5 => NBC=Min(0.25,0.50)=0.25
E0_Avg=0.75 and E1_Lo=0.5 => PSC=Min(0.75,0.50)=0.50
E0_Avg=0.75 and E1_Avg=0.5 => PSC=Min(0.75,0.50)=0.50
Now take maximum of common one that is PSC=0.50; NSC=0.25; NBC=0.25

Step3: Defuzzification Step:

Net Pressure set Point Change=+1*PSC-1*NSC-2*NBC/ (PSC+NSC+NBC)
=+1*0.50-1*0.25-2*0.25/ (0.5+0.25+0.25)
=-0.25

Graph 7A

Graph 7B

Note:VO is the percentage of V_ct that is less than 90% valve opening in 10 minute duration
E1 is the percentage of E_ct that is between zero anf 1 F in 10 minute duration

TRUTH TABLE 7C

	E1(J)	1	2	3
VO(I)		Lo	Avg	Hi
1	Lo	PBC	PBC	PBC
2	Avg.	PSC	PSC	PSC
3	Hi	NBC	NSC	NC

Quantity Changed:

NBC: Negative Big Change=-2 Psi
NSC: Negative Small Change=-1 Psi
NC: No Change=0 Psi
PSC: Positive Small Change=+1 Psi
PBC: Positive Big Change=+2 Psi

Figure - 7

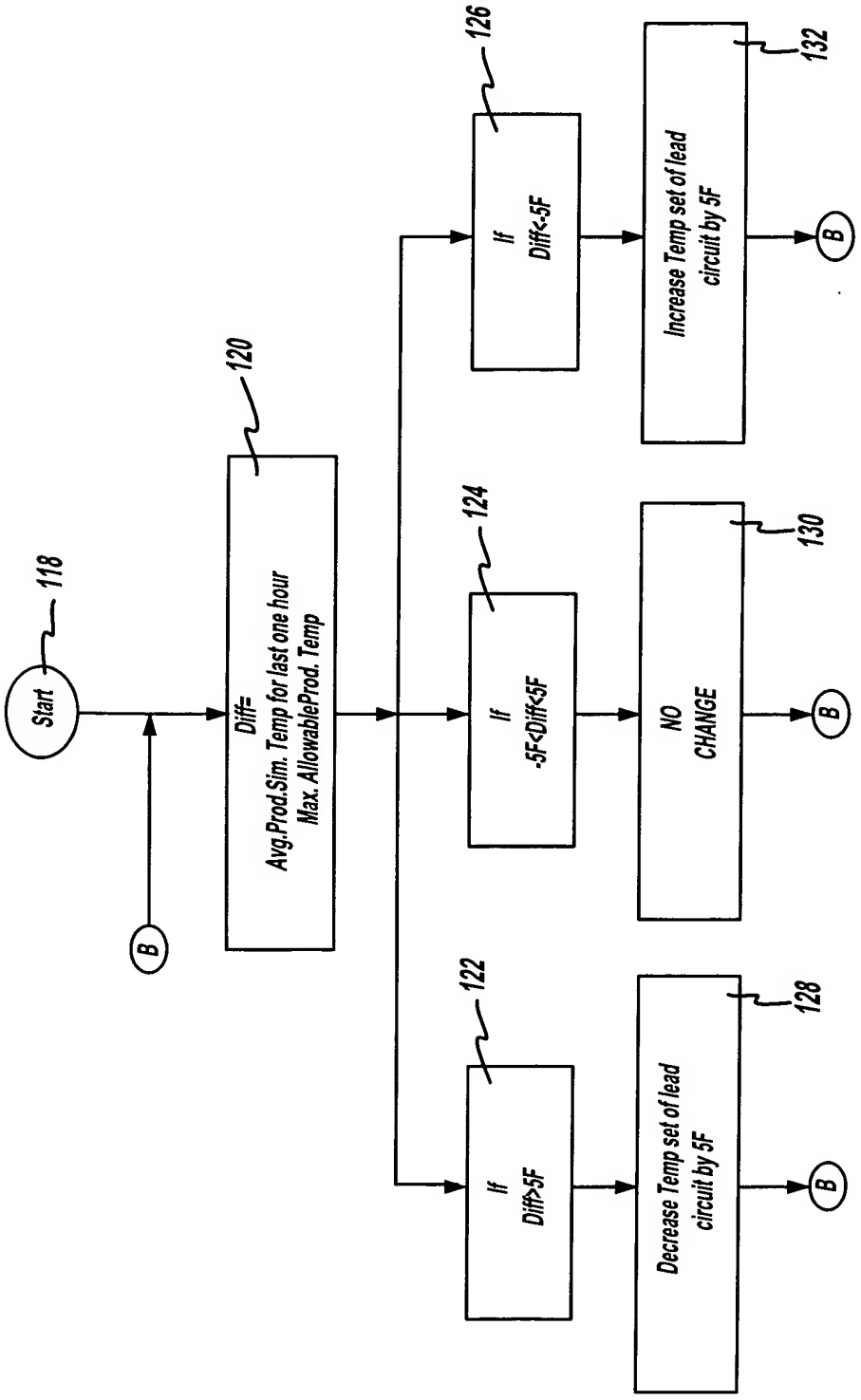
Start
118
B
Diff=
Avg.Prod.Sim. Temp for last one hour
Max. AllowableProd. Temp
120
If
-5F<Diff<5F
124
NO
CHANGE
130
B
If
Diff>5F
122
Decrease Temp set of lead
circuit by 5F
128
B
If
Diff<-5F
126
Increase Temp set of lead
circuit by 5F
132
B

Figure - 8